Marine Physical Laboratory

(2)

Coherence of Transients

Final Report to the
Office of Naval Research
Grant N00014-89-J-1036
for the Period April 1, 1989 to September 30, 1991
William S. Hodgkiss (Principal Investigator)

MPL-U-63/92
June 1992

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University of California, San Diego
Scripps Institution of Oceanography

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. Agency Use Only (Leave Blank).	2. Report Date. June 1992	3. Report Type and Dates Covered. Final Report

4. Title and Subtitle.
Coherence of Transients

5. Funding Numbers.
N00014-89-J-1036

6. Author(s).
W. S. Hodgkiss

Project No.
Task No.

7. Performing Monitoring Agency Names(s) and Address(es).
University of California, San Diego
Marine Physical Laboratory
Scripps Institution of Oceanography
San Diego, California 92152

8. Performing Organization Report Number.
MPL-U-63/92

9. Sponsoring/Monitoring Agency Name(s) and Address(es).
Office of Naval Research
Department of the Navy
800 North Quincy Street
Arlington, VA 22217-5000
Code 1125OA

10. Sponsoring/Monitoring Agency Report Number.

11. Supplementary Notes.

12a. Distribution/Availability Statement.
Approved for public release; distribution is unlimited.

12b. Distribution Code.

13. Abstract (Maximum 200 words).

In this program, new approaches to the estimation of the coherence function and its statistical characteristics have been investigated with a focus on estimating the coherence between transient signals.

14. Subject Terms.
signal processing, coherence function

15. Number of Pages.
2

16. Price Code.

17. Security Classification of Report.	18. Security Classification of This Page.	19. Security Classification of Abstract.	20. Limitation of Abstract.
Unclassified	Unclassified	Unclassified	None

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Objective

In this program, new approaches to the estimation of the coherence function and its statistical characteristics have been investigated with a focus on estimating the coherence between transient signals.

Background

The coherence function is an important measure of relatedness between signals. The calculation of the coherence function, its statistical characteristics, and its use for signal detection has received substantial discussion for extended observations of stationary random processes. By their very nature, transients do not provide extended observation intervals. However, they are an important class of signals which have not yet been fully exploited for the purpose of signal detection and classification. Relatively recent advances in model-based time series analysis techniques have enabled the calculation of high resolution power spectra and their confidence intervals from short observation intervals. These techniques show promise for supplying the auto-spectra and cross-spectra required in the calculation of the coherence function.

Research Results

Three methods of squared magnitude coherence (SMC) estimation were examined. First, the FFT (frequency domain) approach was investigated as a baseline due to its historical significance. Second, a time domain approach was examined which involved fitting an autoregressive (AR) model to the time series and estimating the SMC from the coefficients. Lastly, direct coherence estimation via a least-squares linear prediction approach suggested by Nuttall was investigated.

For short-duration time series, the time-domain SMC estimation approach (AR model) showed the smallest bias and variance, Nuttall's approach showed similar (though noticeably worse) performance, and the FFT method showed the largest bias and variance. Most previous work calculating SMC confidence intervals assumed that SMC estimates are Gaussian distributed. Simulation results show that this assumption holds only for SMC values between 0.3 and 0.8 for both long-duration and short-duration time series. A complete discussion of these results is contained in [1].

Publications

[1] A. Dotan and W. S. Hodgkiss, "Coherence of Transients," TM-422, Marine Physical Laboratory, Scripps Institution of Oceanography, San Diego, CA (1990).

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